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CONVERSION of the VAST FINITE ELEMENT CODE to the DEC ALPHA COMPUTER

by
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CONTRACTOR REPORT

Prepared for

Defence Research Establishment Atlantic

Centre de Recherches pour la Défense Atlantique

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ABSTRACT

A summary of the work related to the development of a RISC-based version of the VAST suite is presented. This work was prompted by DREA's recent decision to replace the aging VAX 6420 VMS mainframe cluster with a number of RISC-based Alpha workstations. A number of problems were encountered during the conversion code, the most significant of which was related to the failure of the FORTRAN intrinsic function "INQUIRE".

Résumé

Un résume des travaux relatifs au développement d'une version à architecture RISC de la suite VAST est présenté. Ces travaux font suite à la décision récente du CRDA de remplacer les gros ordinateurs VAX 6420 VMS vieillissants par des stations de travail Alpha à architecture RISC. Il a fallu faire face à un certain nombre de problèmes durant le portage des codes, dont le plus important est dû à l'échec de la fonction intrinsèque "INQUIRE" du FORTRAN.

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1. INTRODUCTION

A recent review of DREA's computing requirements has resulted in the decision to replace the aging VAX 6420 VMS mainframe cluster with a number of RISC-based Alpha workstations. As a result, much of the code now resident on the mainframe cluster, including the VAST finite element code, must be ported to these new platforms.

Martec Ltd., because of its unique knowledge of the VAST suite, has been tasked by DREA to port the VAST codes to the DEC Alpha computers and to optimize this code for the these platforms. In addition, this work addresses the need to create an X-windows version of the supporting VAST graphics libraries, PLOTVX and PLOTGUI, in order to replace the current GKS or PLOT10 versions.

In the following report, details related to the development and incorporation of Alpha versions of each of the three VAST codes (VASGEN, VAST, and VASTG) will be presented.

2. GENERALIZED WORK PLAN

Since the development of a RISC-based version of the VAST suite required the expertise of a number of Martec professional staff, the most economical approach involved developing the code at the Martec office. Unfortunately, the equipment necessary for the operation of an X-terminal off the Alpha workstations via external modem could not be secured by Martec. As a result, it was decided that the code would be ported initially to Martec's RISC-based Hewlett-Packard 700 series workstation, where the bulk of the code development and testing would be performed. Once the code was deemed to be in a stable condition it would then be ported to DREA's Alpha, where the final refinements and testing could be completed.

3. CONVERSION OF THE VAST SOLVER

The installation of the VAST solver on the Alpha proceeded without any difficulty. Previous experience gained while preparing RISC-based versions of the code for the HP-720 computer allowed Martec staff to generate an executable version of the code on the Alpha workstation relatively quickly.

The source code was transferred from the VAX 6420 to the Alpha workstation (node "BADECK") via the FTP file transfer facility. Unfortunately the verification of the code proved to be difficult due to both the restriction on available disk space on the Alpha workstation and its relatively poor performance when two or more processes were running at the same time.

In order to verify that the output generated by this new RISC-based version of VAST was consistent with the older VMS version, a number of sample problems were run under both operating systems and the results compared. Table 1 provides a complete listing of the analysis options considered. For all models considered, the RISC-based and VMS versions of the VAST solver produced identical results.

TABLE 1: Analysis Options Considered

Analysis Type	Element Types
Static	Solids, shells and beams
Dynamic via modal superposition	Shells and stiffened shells
Dynamic via direct integration	Shells and stiffened shells
Natural frequency	Shells and stiffened shells
Eigenvalue buckling	Shells and stiffened shells
Random response	Beams

4. GENERATION OF X-WINDOWS VERSIONS OF PLOTVX AND PLOTGUI

4.1 XGKS

The X-windows/GKS public domain software source code was downloaded from the US National Centre for Atmospheric Research (NCAR) site. The installation procedures were altered for the HP-UX and SGI UNIX operating systems. The package was then built and tested. It has significantly faster execution speed than a commercially purchased package on our HP720 workstation (GraFPak GKS). VASTG61 and VASGEN61 were ported to the UNIX environment utilizing XGKS, compiled and extensively tested. XGKS has been found to be very stable.

4.2 FSTAT

UNIX lacks the advanced record manager found in VMS. This meant that the large amount of information available in the VMS FORTRAN "INQUIRE" statement (specifically "record length" and "unformatted") was unavailable under HP-UX. A "C" language routine callable from subroutine "SOPEN" in VAST was written to get more information than is available from within FORTRAN. (UNIX is largely written in "C", thus making the C language the "native" UNIX programming language.)

5. CONVERSION OF THE VASTG CODE

A number of problems were encountered during the conversion of the VASTG program, the most significant of which was related to the failure of the FSTAT subroutines. FSTAT is a Martec library routine which checks, among other things, for the existence of data files. In the latest version of the program, FSTAT employed the FORTRAN intrinsic function "INQUIRE" to establish whether the file exists or not. Unfortunately, the "INQUIRE" function did not function properly on the HP-720 and proved to be unpredictable on several other RISC-based platforms as well. Once the difficulty with the "INQUIRE" statement was discovered, a new routine was developed and used to replace the original FSTAT routine. As a result, VASTG required significant modifications.

In addition to the problems related to the "INQUIRE" statement, underflows caused by the conversion of double precision variables to single precision also caused fatal errors. Fortunately, it was discovered that the HP-UX implementation of FORTRAN 77 [1] does provide a trap handling mechanism that allows the developer of the code to control how a program interruption is to be handled. In order to avoid the program "crashing" on an underflow, VASTG was modified to initiate a specific trap procedure which sets the variable to zero whenever underflows occurred. Trap procedures were also developed for arithmetic overflows.

A number of smaller problems were also identified and corrected during the conversion process. These included: the LOGICAL*1 declaration is not allowed; common blocks and subroutines cannot share the same names; variables initialized in DATA statements cannot be changed during

execution of the program and; two-dimensional character variable arrays cannot be declared using formats such as STR*15(5,*), where STR represents the character string variable name.

6. CONVERSION OF THE VASGEN CODE

The failure of the FSTAT routine, and more specifically the FORTRAN 77 "INQUIRE" function, had profound effects on the performance of the VASGEN program. The use of the "INQUIRE" function within VASGEN extended to verification of whether the file in question was opened, and if so, what unit number was the file attached to. Unfortunately, the new routines which were developed to replace the original FSTAT/INQUIRE functions could not be used to establish whether a file was actually opened or not. As a result, the entire file handling logic employed in VASGEN had to be reworked, requiring a significant effort.

REFERENCES

[1] FORTRAN/9000 Reference Manual, published by Hewlett Packard, 1991.

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